Completing the Connection Between Irrigation Districts and On-Farm Irrigation

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The Relationship Between Irrigation Districts and Farmers.

Within the western U.S., many farmers receive all or part of their annual irrigation supply from irrigation districts. State laws govern the details of the formation, administrative and legal organization, financial obligations, voting rights, specific titles (e.g., water district vs. irrigation district vs. water storage district) of irrigation districts. In most cases, irrigation districts in the U.S. are operated as public agencies, with a board of directors composed primarily of farmers. The districts either have water rights or purchase water, and are responsible for conveying and finally distributing the water to individual fields. They are financially self-sustaining and non-profit – raising the majority of their funds through the sale of water and/or taxes on land. Of course, there are many variations of this. Privately held mutual water companies are still very common in some areas of the western U.S.

In the U.S., the legal structure of the irrigation districts and the very local nature of them (farmers pay the bills, and farmers are on the boards of directors, and frequent elections are held for board members) tends to stimulate a "can do" attitude. The water gets delivered with a relatively high degree of equity and reliability. The degree of flexibility of those water deliveries, however, varies greatly depending upon the vision of the board members and staff.

Internationally, there are very few irrigation districts, per se. Instead, there tend to be "irrigation projects" that are administered by large government irrigation agencies. In recent years there has been considerable effort to create sustainable "water user associations (WUA)" in international projects. These WUAs come in all shapes and sizes, with a wide range of expectations. There are some instances of success, such as in Colombia (which has a long history of WUAs), northern Mexico (where farmers are completely dependent upon irrigation rather than rain, plus they are accustomed to operating businesses), and in Turkey. WUAs formed in various areas of the Philippines, Thailand, India, middle and southern Mexico, Morocco, and other areas are generally quite weak or only exist on paper. In many cases, they are declared to exist by legislation and the irrigation authorities, with the hope that the farmers will somehow collect money and pay the government for water, and the farmers will also take over all the maintenance of their areas.

What Farmers Need from Irrigation Districts

The question of what farmers need from an irrigation district is more complicated than it might first appear. It must be framed within the context of factors such as the following:

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a. The ability of farmers, or a willing agency, to pay for improvements in water delivery service.
b. Potential benefits for farmers, in terms of
   - Reduced pumping costs
   - Reduced labor
   - Higher crop yields
c. Special requirements for specific irrigation methods that are being used, or may be used, in an area.

I have noticed that farmers are, as a group, just like any other group of individuals in many ways. There are educated and uneducated farmers, some who focus on the business aspects and others who focus on agronomic aspects, energetic and lazy farmers, and farmers who expect the government to pay for everything and others who believe that farmers also have obligations. And just like any group, a local "champion" or leader is needed if internally-driven change is to occur quickly and effectively.

There are many puzzling things about why farmers irrigate a particular way. ITRC conducted a survey of farmers in the Delano-Earlimart Irrigation District on the subject of perceptions of drip irrigation on trees and vines. About half of the farmers had a very favorable impression of drip, and made extensive use of it. The other half had a very poor impression of it, and weren't about to adopt drip/micro. Likewise, I have noticed that if water is available with a high degree of flexibility, only some of the farmers take maximum advantage of that flexibility for many years after it becomes available.

My conclusion after working in irrigation for over 30 years is that only a few farmers in an irrigation district generally have the vision to dream about what changes in water delivery service flexibility will be needed by farmers in 10 or 20 years. Farmers will have much to say about the price of water, the annual availability of water volumes, and other such topics – but very few will articulate arguments in favor of improved water delivery flexibility to farms. One only needs to attend irrigation district board meetings, or to attend regional meetings of irrigation districts, to realize that the details of water delivery flexibility rarely surface in conversations and meetings.

Yet the bottom line is that there are very few irrigation districts in the U.S. that can support automated farm irrigation. They simply cannot deliver the water with enough flexibility to support turnout delivery flow rate fluctuations that would accompany on-farm automation. So automated farm irrigation systems, where they do exist, are usually found on farms with well supplies, or on farms that have their own buffer reservoirs between the irrigation district and the supply.

The interesting thing is that historically there has been little or no demand by farmers to have enough flexibility to automate their on-farm irrigation. There is, of course, the question of why anyone would want to automate the on-farm irrigation. Many farmers firmly believe that someone needs to be in the field, anyway, because so many things can go wrong during an irrigation.

But an unusual factor is changing the way farmers think, and it's not a desire to automate their irrigation systems for better agronomic results or for saving water – traditional arguments in favor of irrigation system automation. The driving force in California, at least, is the desire to reduce

electricity bills. If farmers can turn off their irrigation pumps between noon and 6 pm (Monday – Friday), their electric bills are decreased substantially. But the irrigation districts must be capable of providing this service.

I think that this is just one example of how external forces (in this case, the price of pumping) are quickly changing the way many U.S. irrigation districts operate. My idea that improved flexibility will need to come from pressure by farmers with a long-term vision may not be correct.

External Pressures on Irrigation Districts

Irrigation district modernization is moving rapidly in the western U.S., and most of that modernization is motivated by external forces – that is, by pressure that originated from a different source than farmers. In addition to the increasing electrical rates mentioned earlier, other such external forces can include:

a. Reduced water availability, such as has happened in the Central Valley Project in California as water has shifted toward endangered species and away from farming. This is also happening on the Colorado River, which may have allocations that exceed water availability.
b. Competition for water. As an example, cities in southern California have looked at irrigation district spills, and farmer tailwater return flows into the Salton Sea and have demanded that those losses be eliminated and the conserved water be used for urban needs. The Klamath Basin in northern California and southern Oregon is in the midst of a huge debate regarding limited water and competing interests of fishermen, Indian tribes, and farmers.
c. Environmental restrictions related to return flows. As an example, in the middle sections of the San Joaquin River, stringent water quality guidelines have been proposed by regulatory agencies. The only way that such guidelines can be met may be to eliminate all surface return flows from irrigation districts. As another example. major irrigation modernization funding in the Yakima (Washington) River basin has come from efforts to improve the water quality for fish in the Yakima River.
d. Requirements that farmers must pay for water on a volumetric basis. This is a favorite topic with donor agencies such as the World Bank and the Food and Agriculture Organization of the United Nations. It has also been a favorite topic here in the U.S. with the US Bureau of Reclamation. In US irrigation districts that receive federal water, there are now requirements that water deliveries be measured volumetrically.

ASSESSING IRRIGATION DISTRICTS FOR MODERNIZATION

ITRC works on irrigation district modernization in almost all of the western states either directly for irrigation districts, or on behalf of agencies such as the US Bureau of Reclamation. We typically become involved in the first stages of modernization, when strategies and overall modernization plans are being developed.

Prior to making recommendations for modernization, each district receives a Rapid Appraisal Process (RAP) by conducted by senior ITRC engineers with a solid background in modernization. An RAP provides an understanding of the operation procedures, and includes a step-by-step tour of the district to learn how water is controlled and conveyed from the source to the individual fields.

ITRC does not use a formal checklist for the U.S. RAPs. However, we have conducted a number of formal evaluations of irrigation district flexibility and characteristics. Reports on the process and results can be found http://www.itrc.org/reports/reportsindex.html

Evaluation of Irrigation Projects in Less Developed Countries

A formalized RAP was developed by Burt and Styles (1999) in response to the need for a standardized procedure for evaluating international irrigation projects. In addition to improving a wide range of external indicators (e.g., Relative Irrigation Supply and Relative Water Supply), they also developed 31 internal indicators that quantify various aspects of water delivery service at all layers within an irrigation projects. Some of the internal indicators quantify the suitability or impact of various factors that influence the degree of service that is provided

ITRC has conducted evaluation training for irrigation district modernization throughout the world, including Uzbekistan, Mexico, Thailand, Nepal, the Philippines, Vietnam, and Pakistan. We have worked closely with the World Bank and FAO to institutionalize the importance of conducting appropriate RAPS before projects are modernized, and to evaluate modernization proposals based on the ITRC RAP principles.

TYPICAL IRRIGATION DISTRICT MODERNIZATION EFFORTS - USA

Within the U.S., modernization efforts have focused on improving the flexibility of water delivery while simultaneously improving the irrigation efficiency of the district (including conveyance efficiency and on-farm irrigation efficiency). Typical actions include modification of check structures to improve water level control, extensive usage of recirculation systems, improved water ordering procedures and software, incorporation of hand-held dataloggers, improved flow measurement and control at all levels, and wide acceptance of SCADA (Supervisory Control and Data Acquisition) systems. Most SCADA systems first emphasize remote monitoring, followed later by remote manual control. Some districts move directly to automation with associated SCADA systems – but the automation is rarely centralized.

In the U.S., most large-scale irrigation automation projects failed until the late 1990's. There are many reasons for these failures, including the lack of understanding of control algorithms, improper SCADA design, poor sensors, inappropriate control applied to canals, poor PLC hardware, etc. But more than anything else, perhaps the failures were caused by the lack of attention to detail. In irrigation automation, the devil is in the details.

ITRC has now developed detailed flow charts for the complete automation process, and we have learned that automation is much more expensive and time consuming than we had earlier thought – if it is to work successfully for a long time. We now have excellent unsteady simulation models, superb control algorithms, an understanding of all the PLC programming steps in addition to programming the algorithms, and knowledge of required PLC, sensor, and SCADA specifications, and good hardware (PLC, sensors, radios, VFD controllers, etc.). We have worked slowly and meticulously to "knock off" each of the traditional stumbling blocks to irrigation district automation.

This work has been possible only with super interactions with a few irrigation district personnel, integrators, and state and federal government agency professionals.

The final hurdle for us has been the relationship with the integrator – the company that does the final installation and programming of the PLC and the Human-Machine-Interface (HMI). We have had tremendous difficulties on this aspect – we think primarily because most integrators actually have very little experience in sophisticated automation. We have recently (within the last 6 months) decided to utilize a universal programming language that is acceptable by all of the major PLC (Programmable Logic Controller) manufacturers, and we will do all of the control logic ourselves. Trying to communicate with integrators about control logic programming has taken more time than if we just do the programming ourselves – which is what we have been forced to do on several projects. This is not to say that we can do without the integrator. The integrator is still needed to do the on-site installation of sensors, PLCs, radios, HMI software in the office, etc. The integrator is also responsible for calibrating sensors and much of the up-front programming that checks for voltages, sensor activity, availability of power to gates, etc.

TYPICAL IRRIGATION DISTRICT MODERNIZATION EFFORTS - INTERNATIONAL

In international projects, modernization efforts have been much less extensive. In the study by Burt and Styles (1999), it was difficult to find 16 projects that had received even some aspect of modernization. Most "modernization" efforts focus on canal lining and rehabilitation of existing structures, rather than on improvements. Furthermore, there is almost always confusion between employing a single hardware device, versus a comprehensive analysis of modernization to improve service. This inappropriate approach, combined with a frequent but unrealistic hope that some type of centralized computerized management or control equals modernization, almost always yields less-than-spectacular results.

There is also an incorrect perception by persons in major donor agencies such as the World Bank that the ills of international irrigation projects can be solved almost exclusively through "software", sometimes referred to as Irrigation Management Transfer (IMT) or as Participatory Irrigation Management (PIM). One should not forget that IMT – the transfer of responsibilities from the central government to local water user organizations – requires that the newly formed water user associations receive water in a usable, equitable, and reliable manner. Without such security, the water user associations have historically failed.

But perhaps the biggest challenge internationally is a lack of attention to details, combined with improperly selected expert companies and individuals. The automation/modernization is often shoved inside larger rehabilitation projects that can only be administered by large construction firms – who may have little or no true experience in modernization. This is exacerbated by a common requirement that modernization on a complete project be finalized within a couple of years after approval. In the U.S. we could rarely if ever achieve success with such a short timeline. It just takes time for people to "get up to speed".

Over the years I have developed a list of factors, any one of which will almost guarantee failure of modernization programs. Some of these factors include:

a. A desire to model the hydraulics of a complete system. I have never needed to do this. Granted, we do model a canal if gates are to be automated – but we do not model beyond that.
b. The existence of a large gap between what project managers state is occurring in the project, versus what actually exists in the project.
c. Money spent on developing computer models to route flows through an irrigation system – especially when based upon numerous assumptions that will never occur in the field.
d. An inadequate budget for maintenance, spare parts, and long-term support.
e. Dirty offices and bathrooms without good plumbing. This indicates a lack of concern for details, and the lack of motivated staff and management.
f. A staff that has no motivation for working well and hard, and which cannot be fired for poor performance.
g. A modernization plan that does not require many years for implementation, and that does not include very deliberate implementation in the field and adequate training and budget.
h. No local "hero" who lives at the project and who will make certain that things work out.
i. A plan that focuses only on computers and PLC-based automation, and does not put a substantial percentage of the budget into simple structures and recirculation systems.
j. An operation plan that dictates gate movements from the central office.
k. The lack of a "service mentality" at all levels within the irrigation project.

A minimum of 3-5 of the points above pertain to almost all international irrigation projects that I have visited in 25 countries over the years.

A POSITIVE SUMMARY

Irrigation districts throughout the western U.S. are very actively involved in modernization efforts that will continue for several decades. The motivation for modernization has largely come from non-agronomic sources. But when modernization is appropriately designed, the water delivery flexibility to farmers is substantially improved while simultaneously responding to external forces.

ITRC has developed a benchmarking procedure to quantify the quality of service that an irrigation district provides, and to identify the appropriate steps needed to modernize an irrigation district. This RAP has been successfully used to assist dozens of irrigation districts throughout the western U.S. It is being adopted by major donor organizations internationally.

REFERENCES

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